NUI Galway
OÉ Gaillimh

Autumn Examinations 2010/ 2011

Exam Code(s)	4IF
Exam(s)	B.Sc. in Information Technology
Module Code(s)	CT420
Module(s)	
Paper No.	1
Repeat Paper	Y
External Examiner(s)	Prof. Michael O'Boyle
Internal Examiner(s)	Prof. Gerard Lyons
	Dr. Jim Duggan
	Dr. Hugh Melvin
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Instructions: Answer Q1 and any other 3 questions. All questions carry equal marks.

Duration	3 hours
No. of Pages	5
Discipline	Information Technology

Requirements:

MCQ
Handout
Statistical/ Log Tables
Cambridge Tables
Graph Paper
Log Graph Paper
Other Materials

Release to Library: Yes [X] [ ]

Q1. Answer each of the following:

- Using the airbag deployment system found on most cars as an example, distinguish between the **sample rate** and **response time** of a Hard RealTime system (15)
- In context of typical quartz computer clocks, explain the terms **offset, skew** and **drift** as well as the **cone of acceptability** **(15)**
- Many voice codecs use both **Forward Error Correction** and **Packet Loss Concealment** strategies. Explain both terms, giving examples of how they work (10)

Q2. (i) You are asked to develop software to control the **speed and altitude** of an airplane. Using code examples briefly describe how this can be done with Ada and why Ada is a good choice as a programming language in this environment. (15)

(ii) Outline in detail how quartz-based computer system clocks work. Explain in particular how the granularity of system time is impacted by the operation of the clock and how this in turn can impact of the responsiveness of the operating system. (15)

(iii) Show using an example how network asymmetry can seriously degrade NTP performance. (10)

Q3. The diagram below shows a tyre pressure monitoring system (PMS) as deployed in a high-end motorbike. The system continuously measures and controls the (speed dependent) optimal pressure of both tyres via a set of pressure sensors and servo valves. The dash display provides additional information.

i) Distinguish between 5 tasks for the PMS software (to be executed by the computing module in the centre of the diagram) and assign meaningful (and unique!) periods and execution times to them.

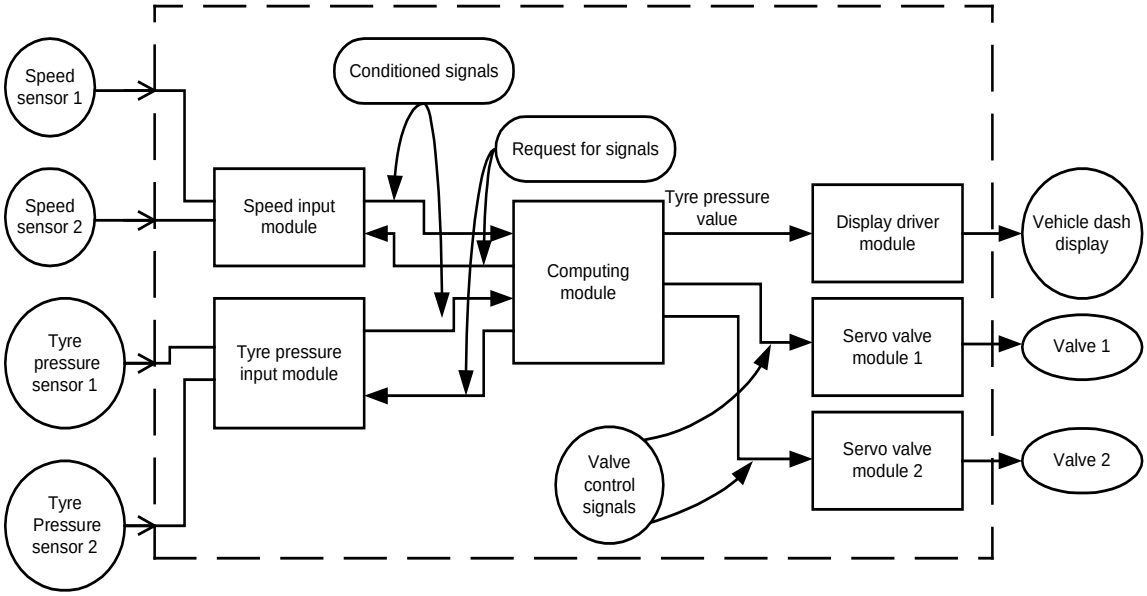
(10)

ii) Using the task structure in i) implement a Cyclic Executive and calculate its time line. Discuss a situation where execution deadlines are not met and provide a solution.

(10)

iii) Enhance your task structure in i) by adding meaningful (and unique!) task priorities. Show how rate-monotonic (RM) scheduling and earliest deadline first (EDF) scheduling will handle the task execution.

(20)



Q4. (i) Briefly outline the role of POSIX in Operating System design.

(10)

ii) You are asked to develop a safety critical application that is required to run on a conventional Linux OS that supports many POSIX.4 features. Explain what POSIX.4 features you would use, how you would use them, commenting also on your choice of programming language.

(30)

Q5. The Hubble Space Telescope (HST) is a space telescope that was carried into orbit by a space shuttle in April 1990. Hubble is one of the largest and most versatile optical systems in space. It is well-known as both a vital research tool and a public relations boon for astronomy.
In this question you will discuss various RTS aspects of this system.

i) Hubble takes high-resolution digital images using its 2.4 m mirror, which are stored locally on a server, before being sent to Earth.
Identify environmental challenges for both the primary (e.g. RAM) and secondary (e.g. hard disk) server storage and discuss in detail how information redundancy on both levels can be increased.

(15)

ii) One of the most important subsystems of the HST is its control momentum gyroscope (CMG) that monitors the position and orientation of the telescope, therefore holding it at a fixed attitude relative to the surface of the earth. The CMG consists of a sensor section (e.g. gyroscope) and a control section (e.g. computer).
Discuss 4 (hypothetical) system failure scenarios and outline how appropriate hardware and software fault tolerant techniques / redundancy can be used for their prevention

(15)

iii) The HST has a radio data link (based on a network of communication satellites) to the Space Telescope Operations Control Center (STOCC) located in Greenbelt, Maryland, where images are archived and further processed. The communication link itself is based on the TCP/IP protocol. What are the benefits and limitations of TCP/IP in such an environment and what other means of transmission and information redundancy would you suggest to use?

(10)

Q6. (i) You are asked to evaluate a range of IP phones using the following criteria:

- Mouth to Ear Delay
- Jitter buffer performance in presence of network jitter
- Perfromance of Packet Loss Concealment strategies in presence of packet loss

Describe in detail the testbed you would use to carry out these tests and the series of tests you would perform. What results would you expect from a phone that performs well across all criteria?

(25)

(ii) Describe what is meant by lip-synch and what constitutes an acceptable level of lip-synch for a voice/video conference session. (5)

(iii) Outline how the RTP and RTCP SR protocols can be used to implement lip synchronisation for voice/video multimedia streams.

(10)